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APPLICATION UNDER UNITED STATES PATENT LAWS

Invention: **CLOSED CIRCUIT TELEVISION (CCTV) CAMERA AND SYSTEM**

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[X] Regular Utility Application

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SPECIFICATION

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CLOSED CIRCUIT TELEVISION (CCTV) CAMERA AND SYSTEM

The present invention relates to a closed circuit television (CCTV) cameras and systems, and more particularly to multi camera CCTV systems.

Such multi camera CCTV systems may include tens or even hundreds of cameras. Monitors are installed remote from the cameras and are usually watched by operators in a central control room or monitoring centre.

Multi camera CCTV systems are used increasingly to improve security and safety in a myriad applications, including offices, car parks, shopping malls, on motorways, railways, and airports.

Analogue images obtained by the cameras may be transferred to the monitoring centre by cable which is connected to each camera. The installation of cables may be costly, or may not be practical for some situations where, for instance, only mobile cameras can be used. In such situations CCTV systems send images via a radio frequency (RF) link. Such RF links have limited bandwidth and therefore limit the amount of cameras which may be used in any one system.

Large amounts of data are produced from digital cameras. Data compression techniques therefore may be used in wireless (RF) CCTV monitoring systems. However, even these were not able to allow all cameras to transmit at the same time. Therefore operators have had to switch sequentially from one camera to the next in order to monitor premises or check what was happening at a particular location.

A problem has been that sometimes an event has occurred at a location which was not being viewed at the time an event occurred.

The present invention arose in an attempt to overcome this and associated problems.

According to a first aspect of the invention there is provided; a camera having means for determining whether information detected in its field of view includes a moving object; processing means for determining whether said moving object exceeds a predetermined threshold; and means for transmitting at least a portion of said moving image to a remote location.

The means to obtain information preferably includes a charge coupled device (CCD) and a microprocessor arranged to discriminate between static and moving pixels or moving portions of an image. Means may be provided to modify a signal so that it is prioritised over another signal. Thus one or more cameras are configured and/or switched automatically to send image data to a monitoring centre when there is an event of interest occurring in the field of view of a camera.

According to another aspect of the present invention there is provided a Closed Circuit Television (CCTV) system including a plurality of CCTV cameras and a communication channel from each of said cameras to at least one monitor; characterised in that means is provided at a camera to obtain information indicative of displacement of an object in the camera's field of view and processing means is provided to determine whether said information exceeds a predetermined threshold, whereby if said threshold is exceeded an override signal is generated, which override signal switches the monitor to receive from said camera.

Each camera may be incorporated with a motion or infra red sensor so that images are transmitted only if movement is detected. Cameras may be adapted to follow or track a moving object. If an infra red motion detector is used to detect presence of an object in a camera's field of view, this may be configured to act as an initial warning or alert that activity is occurring in a particular camera field of view. This information may be used as an initial prioritisation of a transmitted signal and switch a monitor accordingly. In addition a higher priority may be accorded by the processing means and means for determining whether a predetermined threshold is exceeded. This is because the higher priority has associated with it a quantitative element. Thus, for example, the former

embodiment may be activated by animals such as birds or cats; whereas when combined with the latter embodiment discrimination of such events is provided.

Means may also be provided to detect areas of interest and/or to obtain information indicative of features in the images. Preferably means is provided to determine whether said information contains data indicative of any events of interest for the purposes of surveillance and monitoring. If said data is obtained and/or exceeds a predetermined threshold, an override signal is generated, which override signal switches a transmitter to transmit the image data of said camera to a monitor. The invention enables one or more portions of an image frame to be transmitted, if for example, these areas of interest contain events of interest and there is a risk of a channel reaching its capacity. Thus in the unlikely event of several cameras transmitting data at the same time, a monitor may be adapted to receive images from more than one camera at the same time, for example, by reconfiguring a scream into two or more sections. Alternatively an image store, such as a buffer, may be provided. The image store enables once retrieved, an image to be viewed at a different time from another.

Means is preferably also provided to determine which portion of the data is useful and which portion of the data is superfluous, such as static objects. Advantageously means is provided to encode data to be transmitted in for example, MPEG 4 format, so as to reduce the amount of transmitted data.

The means to obtain information preferably includes a charge couple device (CCD) and a microprocessor, frame store, and/or dedicated circuits such as ASIC's, to discriminate pixel features. The said microprocessor and ASIC's may be configurable and programmable, and may be able to communicate with other cameras via one or more communication channels.

Actuator means for displacing the field of view of the camera may be provided. The actuator means may be operated under control of a microprocessor which is arranged to displace the camera so that objects of interest are maintained within a field of view.

Artificial intelligence, for example in the form of a neural network, may be included in the system.

In order to increase channel carrying capacity means may be provided to discriminate moving portions of an image and image portions occupied by objects. Discriminating moving portions of an image may be implemented by a motion detector using consecutive images. Discriminating image portions occupied by an objects may be implemented by object detector using an adopted reference image containing only background image information.

Means may also be provided to detect movement direction, or main direction of movement if there are multiple directions in the view of camera, so that the camera may be adapted to follow or track the moving object/objects.

Embodiments of the invention will now be described, by way of example only, and with reference to the Figures, in which:

Figure 1 shows a block diagram of an example of a camera in accordance with the invention;

Figure 2 shows a functional block diagram of a camera processing unit;

Figure 3 shows a block diagram of a moving edge detector which is incorporated into the camera to detect moving objects;

Figure 4 shows a block diagram of an object detector; and

Figure 5 is an overall view of a system including four cameras.

Figure 1 shows a block diagram of a camera 2, which includes Processing Unit 10 and MPEG 4 encoder 4. An actuator 8 is provided to move camera 2 in a controlled

manner, eg, by tilting, panning or zooming. Processing unit 10 is shown in greater detail in Figure 2.

Referring to Figure 1, camera 2 has a lens 6 and an image detector which is preferably a charge coupled device (CCD). Outputs of camera 2 are a transmission Request Signal, to request a transmitter to transmit data when there is an event detected and Tracking Control signal, to control actuator 8 to follow event movement. Whole Image is the same image as obtained from a normal camera. Area of Interest (AOI) Image outputs images in area of interest. MPEG 4 Image outputs MPEG 4 encoded images of an AOI Image.

Operation of the camera will now be described, with reference to Figure 2. Referring to Figure 2, three frames of sequential video images 11 are stored in three frame stores, FS1 21, FS2 22 and FS3 23. Using the three images, a moving edge detector 31 detects moving edges in an image and generates a moving edge image. A reference image 32 containing only background image data is used to compare with sequential images in order to detect whether objects are present in the camera's field of view. The reference image may automatically be adopted whenever there is not an object detected so as to overcome the problem of change of ambient lighting conditions. By comparing a reference image 32 with images from FS2 22, the object detector 33 detects whether or not there are events of interest present in the images.

Using the information inherent in moving edge images, and of objects detected, three features can be detected. These are: events of interest, directions of moving objects and areas of interest. Detection is by way of high level of analysis. Interest Analyser 43 estimates whether there is an event of interest in the field of view. This may be an object/or person present, or just a static background. From the event of interest detected, means for decision making 50 determines when or which images are to be transmitted. Area of interest (AOI) analyser 42 measures an area of interest in the image in the region where an event of interest is detected. Thus, only data in AOI is transmitted. Other parts of the image are ignored as they are relatively static and therefore discarded. Thus bandwidth is saved. By using the technique of block matching, direction analyser

41 detects an overall direction of movement of the event. This information may be used to control an actuator so that if present, actuator 15 controls camera 2 in order to follow an event of interest.

From the three variables: events of interest, directions of moving objects and areas of interest, decision making means 50 generates three signals, A, B and C. Signal A informs image buffer 60 to be ready to send an image and which part of the image is to be sent. Signal B requests transmitter to transfer images by overriding any existing channel. Signal C controls camera 10 in Figure 1 so that it tracks the events of interest if necessary, by tilt, pan or zoom. The image is then encoded by MPEG 4 encoder and transmitted either via a hardwire (fibre optic) connection or as an rf, VHF or UHF signal.

Moving edge detector is illustrated diagrammatically in Figure 3. Three consecutive images of sequential video images 11 are stored in three frame stores, FS1 21, FS2 22 and FS3 23, and used for moving edge detection. $I_1(x,y)$, $I_2(x,y)$ and $I_3(x,y)$ denote the three consecutive images respectively. The input of Edge Detection 32 is $I_2(x, y)$ and its output is $E_2(x,y)$ is an edge image from image $I_2(x,y)$. Inputs of temporal difference (1) 31 are $I_1(x,y)$ and $I_2(x,y)$, and output is a difference image $D_{12}(x,y)$ which is defined as the following equation:

$$D_{12}(x,y) = |I_1(x,y) - I_2(x,y)| \qquad \text{Eqn (1)}$$

The inputs of temporal difference (2) 33 are $I_2(x, y)$ and $I_3(x, y)$, and its output is a difference image $D_{23}(x, y)$ which is defined in equation 2 as the follows:

$$D_{23}(x,y) = |I_2(x,y) - I_3(x,y)| \qquad \text{Eqn (2)}$$

The inputs of Multiplication 41 are $D_{12}(x,y)$. $E_2(x,y)$ and $D_{23}(x,y)$ and its output $M(x,y)$ is calculated as the follows:

$$M(x,y)= D_{12}(x,y).E_2(x,y).D_{23}(x,y) \qquad \text{Eqn (3)}$$

The output of threshold device 42 is the moving edge image *ME(x,y)* 12, which is defined as follows:

$$\mathrm{ME}(x,y) = \begin{cases} M(x,y), if M(x,y) > T_m \\ 0, Otherwise \end{cases} \qquad \text{Eqn (4)}$$

where $\mathbf{T_m}$ is a threshold for moving edge detection.

An example of object detector is illustrated in Figure 4. Frame store FS2 21 contains the input image 11, which is one of the sequential images of camera 2 and may contain objects. Reference Image 22 is a frame store containing a reference image which contains only background image. The reference image may automatically be adopted by input image 11 whenever there is not an object detected in the image. Thus, the problem of changes in light intensity can be overcome. Let I_2 (x,y) and *R(x,* y) denote the image in FS2 and the reference image respectively. By comparing I_2 (x, y) and *R(x,* y), the Intensity Subtraction 23 generates a difference image *D(x,y)*, which is calculated as the follows:

$$D(x, y) = | I_2 (x,y) - R(x, y) | \qquad \text{Eqn (5)}$$

Then, using a technique of thresholding, the output O(x,y) of thresholding means 31 is defined as follows:

$$O(x,y) = \begin{cases} 1, if d(x,y) > To \\ 0, Otherwise \end{cases} \qquad \text{Eqn (6)}$$

where 1 indicates that the pixel is an object pixel, 0 indicates that the pixel is a background pixel, and T_o threshold for object detection.

Through analyser 32, the output signal 12 indicates whether an object or objects have been detected.

Figure 5 is a diagramatical overall view of a system 100 including four cameras 100A, B, C and D. Cameras 100 A and B are connected to a monitoring station 104 via hard wire connectors. Cameras 100C and D are connected to monitoring station 104 via rf transmitters 106C and 106D and via rf receiver 108.

Monitoring station 104 is connected to a plurality of monitors 110 of which only one is shown. The screen 112 of the monitor is capable of being divided into four sections and images from one or more cameras displayed in the or each section.

The invention has been described by way of examples only and variation may be made to the embodiments described without departure from the scope of the invention.